

# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-138213

(43)Date of publication of application : 31.05.1996

(51)Int.Cl.

G11B 5/39

(21)Application number : 06-273272

(71)Applicant : HITACHI LTD.

(22)Date of filing : 08.11.1994

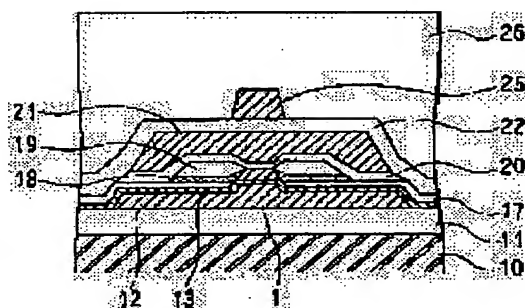
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## (54) MAGNETO-RESISTIVE EFFECT TYPE HEAD

### (57)Abstract:

**PURPOSE:** To obtain a structure with which the spacing between the lower shielding film and upper shielding film of the magnetosensitive part region of a magneto-resistive effect head is made small and the stable insulating characteristic of an electrode film and the magnetic shielding films is assured in order to improve a surface recording density.

**CONSTITUTION:** The lower magnetic shielding film 12 is disposed on a substrate and a magneto-resistance sensor film 1 is disposed via an insulating film in the magnetosensitive part region on this lower magnetic shielding film 12. The electrode film 19 for energization is connected to the side face of the magneto-resistance sensor film 1. The thickness of the insulating film between the magneto-resistance sensor film 1 in the magnetosensitive part region and the lower magnetic shielding film 12 is set smaller than the thickness of the insulating film between the electrode film 19 and the lower magnetic shielding film 12.



## LEGAL STATUS

[Date of request for examination] 28.02.2001

[Date of sending the examiner's decision of rejection] 20.04.2004

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection] 2004-10495

[Date of requesting appeal against examiner's decision of rejection] 20.05.2004

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[Date of extinction of right]

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(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平8-138213

(43) 公開日 平成8年(1996)5月31日

(51) Int. Cl.<sup>6</sup>

G 1 1 B 5/39

識別記号

庁内整理番号

F I

技術表示箇所

審査請求 未請求 請求項の数3 O L (全 7 頁)

(21) 出願番号 特願平6-273272

(22) 出願日 平成6年(1994)11月8日

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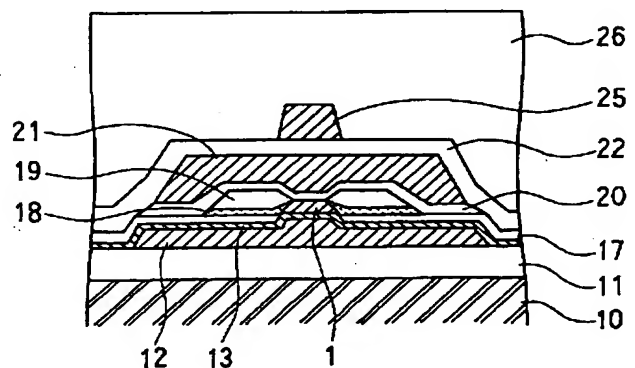
(54) 【発明の名称】 磁気抵抗効果型ヘッド

(57) 【要約】

【目的】 面記録密度を向上させるため、磁気抵抗効果型ヘッドの感磁部領域の下部シールド膜と上部シールド膜の間隔を小さくし、かつ、電極膜と磁気シールド膜との安定した絶縁性を確保した構造を提供すること。

【構成】 基板上に、下部磁気シールド膜12と、この下部磁気シールド膜12上の感磁部領域に絶縁膜を介して磁気抵抗センサ膜1を設け、磁気抵抗センサ膜1の側面に通電用の電極膜19を接続し、感磁部領域の磁気抵抗センサ膜1と下部磁気シールド膜12の間の絶縁膜の厚さを、電極膜19と下部磁気シールド膜12の間の絶縁膜の厚さより薄くした磁気抵抗効果型ヘッド。

図 1



12…下部シールド膜

13…第1の絶縁膜

17…第2の絶縁膜

18…縦バイアス膜

19…電極膜

20…上部ギャップ膜

21…上部シールド膜

22…ライトギャップ膜

25…ライトコア

26…保護膜

## 【特許請求の範囲】

【請求項1】基板と、該基板上に設けられた下部磁気シールド膜と、該下部磁気シールド膜上の感磁部領域に絶縁膜を介して設けられた磁気抵抗センサ膜と、この磁気抵抗センサ膜の側面に接続された通電用電極膜を有する磁気抵抗効果型ヘッドにおいて、上記磁気抵抗センサ膜と下部磁気シールド膜の間の絶縁膜の厚さが、上記電極膜と下部磁気シールド膜の間の絶縁膜の厚さより薄いことを特徴とする磁気抵抗効果型ヘッド。

【請求項2】請求項1記載の磁気抵抗効果型ヘッドにおいて、上記下部磁気シールド膜は、上記感磁部領域に凸部を有することを特徴とする磁気抵抗効果型ヘッド。

【請求項3】請求項1記載の磁気抵抗効果型ヘッドにおいて、上記電極膜と下部磁気シールド膜の間の絶縁膜は、その厚さ方向の全部又は主要部が、上記磁気抵抗センサ膜と下部磁気シールド膜の間の絶縁膜と異なる材質からなることを特徴とする磁気抵抗効果型ヘッド。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】本発明は、磁気記録分野、例えば、磁気ディスク装置等に用いられる磁気抵抗効果型ヘッドに関する。

## 【0002】

【従来の技術】近年、高密度記録再生用ヘッドとして磁気抵抗効果型ヘッド（以下、MRヘッドという）を使用した磁気記録装置が用いられるようになってきている。このMRヘッドは、バルクハウゼンノイズを抑止し、線形性の良い動作領域を確保するために、磁気抵抗センサ膜に縦方向及び横方向のバイアス磁界を印加しなければならないことが知られている。

【0003】また、高密度記録対応の狭トラック幅のMRヘッドとして、特開平3-125311に、磁気抵抗センサ膜を感磁部のみに限定して配置し、磁気抵抗センサ膜の側面に電極を接続した構造の感度分布の優れた狭トラック幅のMRヘッドが開示されている。このMRヘッドは、磁気抵抗センサ膜を、マスク材としてフォトリジストを用い、イオンビームの入射角を制御したイオンミリング法により、テーパエッチングすると共に、これに接続した電極膜を形成して製造されている。

## 【0004】

【発明が解決しようとする課題】磁気記録の分野では、今後益々面記録密度を向上させて行くことが必要であるが、面記録密度を向上させるためにはトラック密度に加えて線記録密度も大幅に向上させて行くことが必要である。そのためにはMRヘッドのギャップ長、すなわち感磁部領域（磁気抵抗センサ膜の動作領域）の下部シールド膜と上部シールド膜の間隔を小さくする必要がある。

【0005】上記特開平3-125311に記載の従来技術は、感磁部領域の下部シールド膜と上部シールド膜の間隔が、高密度記録に対応した広さでないという問題

があった。もしも、このMRヘッドの絶縁膜を薄くすると、イオンミリングによって磁気抵抗センサ膜をエッチングするときに、下地の絶縁膜がオーバーエッチングされるため、この上に形成された電極膜と下部シールド膜との絶縁性の確保は困難である。

【0006】本発明の目的は、感磁部領域の下部シールド膜と上部シールド膜の間隔が小さく、かつ、電極膜と磁気シールド膜との安定した絶縁性を確保した磁気抵抗効果型ヘッドを提供することにある。

## 【0007】

【課題を解決するための手段】上記目的を達成するために、本発明の磁気抵抗効果型ヘッドは、基板と、基板上に設けられた下部磁気シールド膜と、下部磁気シールド膜上の感磁部領域に絶縁膜を介して設けられた磁気抵抗センサ膜と、この磁気抵抗センサ膜の側面に接続された通電用電極膜を有し、磁気抵抗センサ膜と下部磁気シールド膜の間の絶縁膜の厚さを、電極膜と下部磁気シールド膜の間の絶縁膜の厚さより薄くするようにしたものである。

【0008】この磁気抵抗効果型ヘッドは、感磁部領域の下部磁気シールド膜に凸部を設けた構造とすることができる。このような磁気抵抗効果型ヘッドは、例えば、次のようにして容易に製造することができる。基板上に下部磁気シールド膜を形成し、この下部磁気シールド膜の磁気抵抗センサ膜が形成される感磁部領域以外の膜厚を薄くし、その上に、第1の絶縁膜、第2の絶縁膜を形成し、感磁部領域の第2の絶縁膜を削除して製造する。

【0009】また、上記磁気抵抗効果型ヘッドは、電極膜と下部磁気シールド膜の間の絶縁膜の厚さ方向の全部又は主要部を、磁気抵抗センサ膜と下部磁気シールド膜の間の絶縁膜と異なる材質とすることもできる。このような磁気抵抗効果型ヘッドは、例えば、次のようにして容易に製造することができる。まず、基板上に下部磁気シールド膜、第1の絶縁膜、磁気抵抗センサ膜を形成し、感磁部領域以外の磁気抵抗センサ膜、第1の絶縁膜を除去する。このとき第1の絶縁膜は上部の一部だけが除去されて、一部が残っていてもよい。ついで、第2の絶縁膜を、第1の絶縁膜が実質的に除去された領域に形成する。このように、絶縁膜を2回に分けて異なる材質で形成すれば、上記の構造を容易に製造することができる。

## 【0010】

【作用】感磁部領域の磁気抵抗センサ膜と下部磁気シールド膜の間の絶縁膜の厚さを薄くすれば、下部シールド膜と上部シールド膜の間隔を薄くすることができ、高密度記録に対応できる。一方、電極膜と下部磁気シールド膜の間の絶縁膜の厚さは、上記感磁部領域の絶縁膜の厚さより厚くすることによって、電極膜と下部磁気シールド膜との安定した絶縁性を確保することができる。

## 【0011】

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【実施例】以下、図面を用いて本発明の実施例を説明する。

〈実施例1〉図1は本発明の第1の実施例のMRヘッドの媒体対抗面（浮上面）の素子部構造図、図2及び図3はその製造工程を示すための部分構造図である。基板10上に、下地膜11、厚さ2 $\mu$ mの下部シールド膜12を形成し、下部シールド膜12の一部、すなわち、後に形成する磁気抵抗センサ膜1の領域以外の部分を膜厚が薄くなるように、イオンミリングにより約0.5 $\mu$ mエッチングする。ここで形成された下部シールド膜12の凸部の幅は2 $\mu$ mであり、記録媒体のトラック幅に対応する。通常は1.5 $\mu$ mから3 $\mu$ mとすることが好ましい。下部シールド膜12には軟磁性膜であるNiFe膜のアモルファス合金膜を用いたが、CoNbZr等のアモルファス合金膜でもよい。

【0012】続いて図2に示すように、厚さ0.1 $\mu$ mの第1の絶縁膜13及び厚さ約1 $\mu$ mの第2の絶縁膜17を形成し、ポリシング加工によって、図3に示すように第1の絶縁膜13が露出し、概略平坦面が得られるまで加工する。第1の絶縁膜13の厚さは0.05 $\mu$ mから0.1 $\mu$ mが好ましく、第2の絶縁膜17の厚さは、上記エッチングした厚さの0.5 $\mu$ m以上であればよい。ここで、第1の絶縁膜13には硬質でポリシング加工で加工され難いカーボン絶縁膜（ダイヤモンドライクカーボン膜）、第2の絶縁膜17にはAl<sub>2</sub>O<sub>3</sub>を用いたが、第2の絶縁膜17にはSiO<sub>2</sub>等を用いてもよい。

【0013】図4及び図5はこの平坦面を形成する上での別のやり方を示した部分構造図であり、この場合には第1の絶縁膜13が一部加工されて薄くなった状態又は加工されてなくなった状態から、再度第1の絶縁膜に相当する絶縁膜27を形成するもので機能的には図3に示す構造と同じである。

【0014】この後、図1に示す磁気抵抗センサ膜1を形成するが、この磁気抵抗センサ膜1は、図6に示す部分構造図のように3層以上の膜からなっている。図6の例ではソフトバイアス膜14、分離膜15、MR膜16を連続形成する。ここで、ソフトバイアス膜14には一般的に知られている高抵抗軟磁性合金であるNiFeCr、NiFeNb等を用い、分離膜15にはTa、MR膜16にはNiFeを用いて順次積層膜を形成して行く。

【0015】次に、図6に示すようなマスク材となるステンシル31を下部シールド膜12の膜厚が厚いところに位置合わせしてフォトリソで形成し、イオンミリングによってソフトバイアス膜14、分離膜15、MR膜16の3層をエッチングする。このとき必要な側面テーパ角を得るために、イオンビームの入射角を45度以上の大きな値に設定して基板を回転しながらエッチングする。ここで、基板面内を確実にエッチングするためには基板面内の一部はオーバーエッチされ、図6に示すよ

うに第2の絶縁膜17も若干エッチングされてしまうことになるが、膜厚を十分厚くしているので下部シールド膜12上の第2の絶縁膜17は必要な膜厚が確保されることになる。

【0016】続いてこの状態から、ステンシル31を残したまま、図7に示すように、MR膜16に縦バイアスを印加するための縦バイアス膜18と電極膜19を連続積層する。縦バイアス膜18にはCoCrPtのハード膜、電極膜には低抵抗のTa/Au/Taを用いたが、縦バイアス膜18はNiMn/NiFeの積層膜等でもよく、電極膜はTa/W/Taの積層膜等でもよい。形成法は金属膜被着粒子の回り込みの大きな通常のスパッタ法で形成する。いずれの方法で製造しても、本実施例では、磁気抵抗センサ膜と縦バイアス膜の下層面は実質的に平坦となっている。

【0017】この後、ステンシル31を除去すると図8に示す形状が得られる。この後図9に示すように上部ギャップ膜20、下部シールド膜と同じ材質の上部シールド膜21を形成し、図1に示すライトギャップ膜22、コイル（図示せず）、層間絶縁膜（図示せず）、ライトコア25、保護膜26、端子（図示せず）等を形成してMRヘッドを完成させる。図10は、このMRヘッドの部分斜視図で、コイル23、層間絶縁膜24等の位置を示す。

【0018】〈実施例2〉図11は本発明の第2の実施例のMRヘッドの媒体対抗面（浮上面）の素子部構造図、図12から図16はその製造工程を示すための部分構造図である。基板10上に下地膜11、下部シールド膜12、第1の絶縁膜13を形成し、続いて磁気抵抗センサ膜1を形成する。下部シールド膜12及び第1の絶縁膜13の材質、厚さは実施例1と同じとしたが、第1の絶縁膜13には、カーボン絶縁膜でなくて、窒化シリコン、アルミナ、チタニア等の絶縁性のある高純度金属化合物等を用いてもよい。

【0019】磁気抵抗センサ膜1は、図12に示すようにソフトバイアス膜14、分離膜15、MR膜16の3層からなっており、これらを連続形成する。これらのソフトバイアス膜14、分離膜15、MR膜16には実施例1記載の材料を用いる。

【0020】次に、図12に示すようなマスク材となるステンシル31をフォトリソで形成し、イオンミリングによってソフトバイアス膜14、分離膜15、MR膜16の3層をエッチングするが、このとき必要な側面テーパ角を得るために、イオンビームの入射角を45度以上の大きな値に設定して基板を回転しながらエッチングする。ここで、基板面内を確実にエッチングするためには基板面内の一部はオーバーエッチされ、図12に示すように第1の絶縁膜13が薄い場合にはこの膜もエッチングされてしまうことになる。

【0021】続いてこの状態から、ステンシルを残した

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ま、図13に示すように、厚さ $0.2\mu\text{m}\sim 0.3\mu\text{m}$ の第2の絶縁膜17を形成するが、成膜方法は絶縁膜被着粒子32の指向性の強い方法、例えばイオンビームスパッタ法又は直進粒子を多くしたコリメーションスパッタ法等を用いて、第1の絶縁膜13の側面の一部又は全部を覆うように形成する。またこの膜は絶縁を確保する上で必要な厚さにするので、一般的な金属酸化物、金属窒化物、例えば、窒化シリコン、アルミナ、チタニア等を用いることが可能である。これにより、同一マスク材を用いて第2の絶縁膜17まで形成するので位置ずれが生じ難く、この後形成する電極膜と下部シールド膜との絶縁も確実に確保できることになる。

【0022】この後本実施例では、図14に示すように、MR膜16に縦バイアスを印加するための縦バイアス膜18を形成するが、この時MR膜側面との接触を確実にするため、Arイオンを用いて斜め方向から照射して、側面のクリーニングを事前に行うのが望ましく、縦バイアス膜18と電極膜19を連続積層する。縦バイアス膜18、電極膜19には実施例1と同じ材料を用い、形成法は金属膜被着粒子33の回り込みの大きな通常のスパッタ法で形成する。

【0023】この後、図15に示すように、ステンシル31を除去し、上部ギャップ膜20、上部シールド膜21を形成し、図11に示すライトギャップ膜22、コイル(図示せず)、層間絶縁膜(図示せず)、ライトコア25、保護膜26、端子(図示せず)等を形成してMRヘッドを完成させる。図17は、このMRヘッドの部分斜視図で、コイル23、層間絶縁膜24等の位置を示す。図16は、第1の絶縁膜13が完全にエッチングされなかった場合の部分構造図で、電極膜19下の絶縁膜は、その厚さの大部分が第2の絶縁膜17からなり、この場合も同様な絶縁効果が得られることは明白である。

【0024】

【発明の効果】以上説明したように、本発明のMRヘッドは、感磁部領域の下部シールド膜と上部シールド膜の間隔を狭く保つことができると共に、電極膜と下部シールド膜との絶縁劣化を防止することができた。

【図面の簡単な説明】

【図1】本発明の第1の実施例のMRヘッドの媒体対抗面の素子部構造図。

【図2】本発明の第1の実施例のMRヘッドの製造工程を示すための部分構造図。

【図3】本発明の第1の実施例のMRヘッドの製造工程を示すための部分構造図。

【図4】本発明の第1の実施例のMRヘッドの他の製造工程を示すための部分構造図。

【図5】本発明の第1の実施例のMRヘッドの他の製造工程を示すための部分構造図。

【図6】本発明の第1の実施例のMRヘッドの製造工程を示すための部分構造図。

【図7】本発明の第1の実施例のMRヘッドの製造工程を示すための部分構造図。

【図8】本発明の第1の実施例のMRヘッドの製造工程を示すための部分構造図。

【図9】本発明の第1の実施例のMRヘッドの製造工程を示すための部分構造図。

【図10】本発明の第1の実施例のMRヘッドの素子部の部分斜視図。

【図11】本発明の第2の実施例のMRヘッドの媒体対抗面の素子部構造図。

【図12】本発明の第2の実施例のMRヘッドの製造工程を示すための部分構造図。

【図13】本発明の第2の実施例のMRヘッドの製造工程を示すための部分構造図。

【図14】本発明の第2の実施例のMRヘッドの製造工程を示すための部分構造図。

【図15】本発明の第2の実施例のMRヘッドの製造工程を示すための部分構造図。

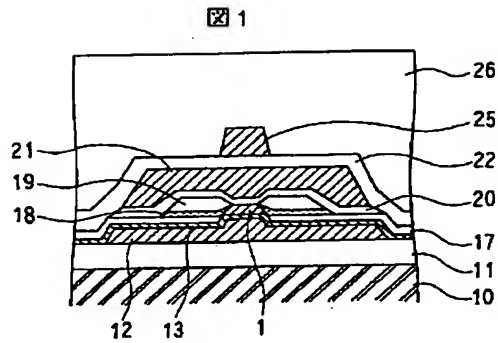
【図16】本発明の第2の実施例のMRヘッドの他の製造工程を示すための部分構造図。

【図17】本発明の第2の実施例のMRヘッドの素子部の部分斜視図。

【符号の説明】

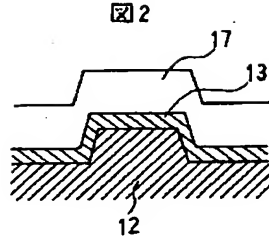
- 1…磁気抵抗センサ膜
- 10…基板
- 11…下地膜
- 12…下部シールド膜
- 13…第1の絶縁膜
- 14…ソフトバイアス膜
- 15…分離膜
- 16…MR膜
- 17…第2の絶縁膜
- 18…縦バイアス膜
- 19…電極膜
- 20…上部ギャップ膜
- 21…上部シールド膜
- 22…ライトギャップ膜
- 23…コイル
- 24…層間絶縁膜
- 25…ライトコア
- 26…保護膜
- 27…絶縁膜
- 31…ステンシル
- 32…絶縁膜被着粒子
- 33…金属膜被着粒子

【図1】



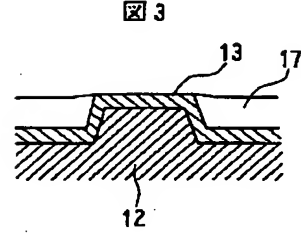
- 12...下部シールド膜  
13...第1の絶縁膜  
17...第2の絶縁膜  
18...縦バイアス膜  
19...電極膜  
20...上部ギャップ膜  
21...上部シールド膜  
22...ライトギャップ膜  
25...ライトコア  
26...保護膜

【図2】



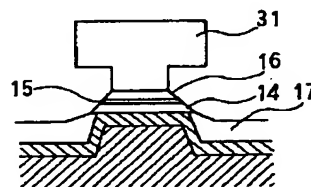
- 12...下部シールド膜  
13...第1の絶縁膜  
17...第2の絶縁膜

【図3】



【図6】

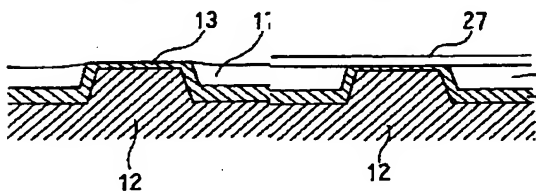
図6



- 14...ソフトバイアス膜  
15...分離膜  
16...MR膜  
31...ステンシル

【図4】

図4



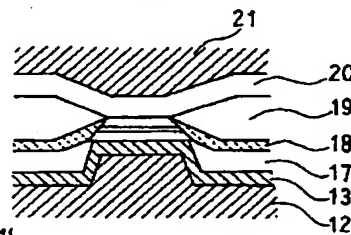
【図5】

図5

- 27...絶縁膜

【図9】

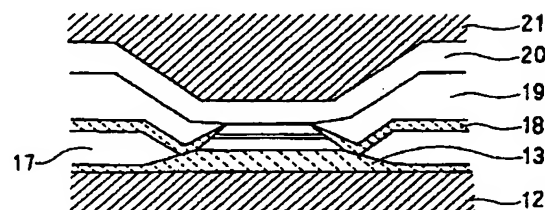
図9



- 20...上部ギャップ膜  
21...上部シールド膜

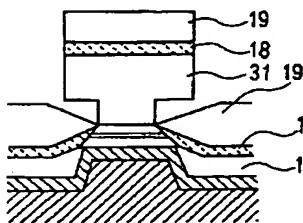
【図16】

図16



【図7】

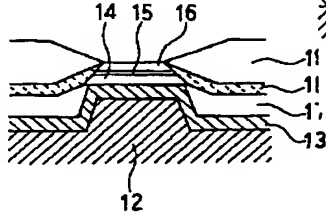
図7



- 18...縦バイアス膜  
19...電極膜

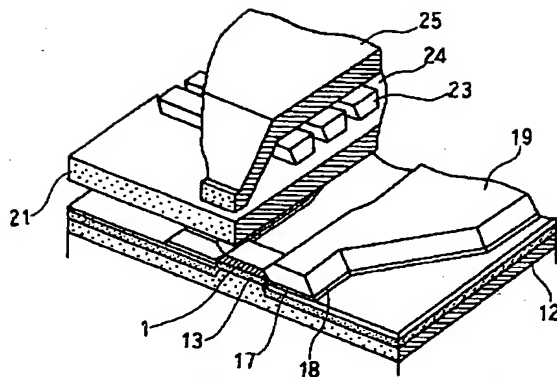
【図8】

図8



【図10】

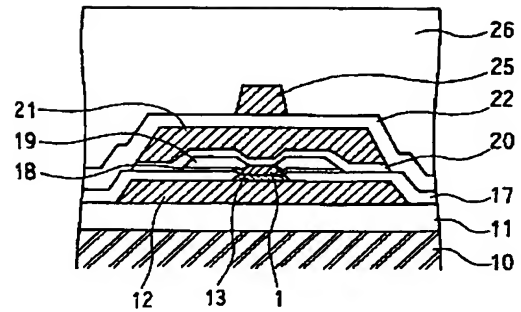
図10



- 13...第1の絶縁膜  
17...第2の絶縁膜  
18...縦バイアス膜  
21...上部シールド膜  
23...コイル  
24...層間絶縁膜

【図11】

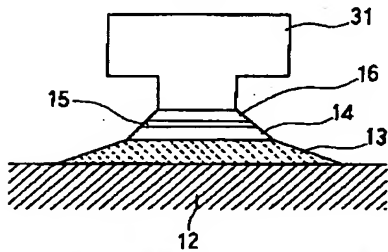
図11



- 12...下部シールド膜  
13...第1の絶縁膜  
17...第2の絶縁膜  
18...縦バイアス膜  
19...電極膜  
20...上部ギャップ膜  
21...上部シールド膜  
22...ライトギャップ膜  
25...ライトコア  
26...保護膜

【図12】

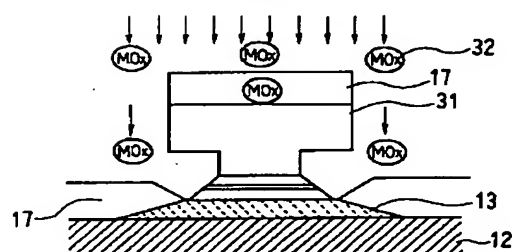
図12



- 12...下部シールド膜  
13...第1の絶縁膜  
14...第2の絶縁膜  
15...分離膜  
16...MR膜  
31...ステンシル

【図13】

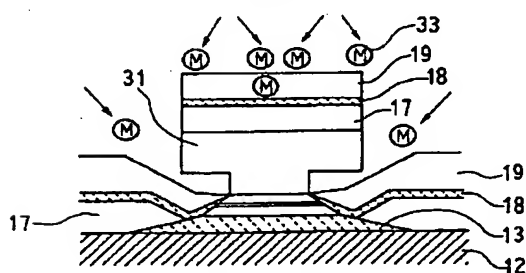
図13



- 32...絶縁膜被着粒子

【図14】

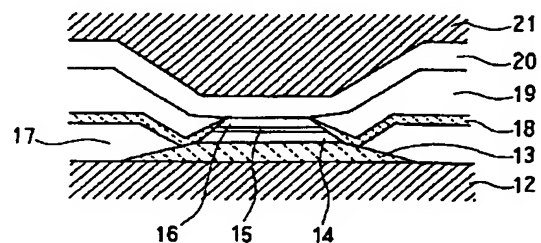
図14



- 33...金属膜被着粒子

【図15】

図15

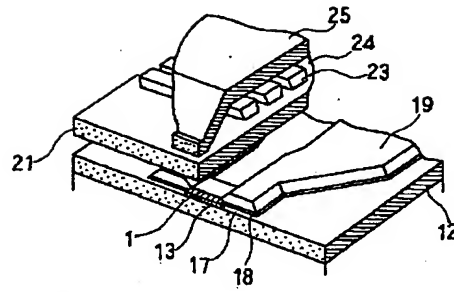


- 18...縦バイアス膜  
19...電極膜  
20...上部ギャップ膜  
21...上部シールド膜



【図17】

図17



13...第1の絶縁膜  
17...第2の絶縁膜  
18...縦バイアス膜

21...上部シールド膜  
23...コイル  
24...層間絶縁膜

## PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-138213

(43)Date of publication of application : 31.05.1996

(51)Int.Cl.

G11B 5/39

(21)Application number : 06-273272

(71)Applicant : HITACHI LTD

(22)Date of filing : 08.11.1994

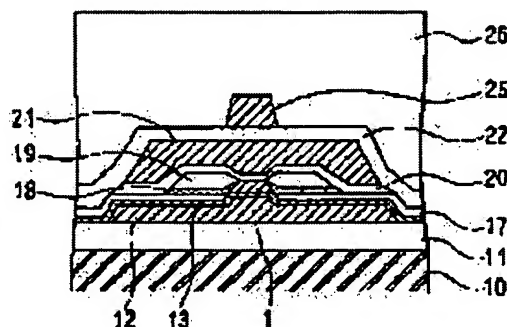
(72)Inventor : KOBAYASHI TETSUO  
WAKAGI YASUO

## (54) MAGNETO-RESISTIVE EFFECT TYPE HEAD

## (57)Abstract:

PURPOSE: To obtain a structure with which the spacing between the lower shielding film and upper shielding film of the magnetosensitive part region of a magneto-resistive effect head is made small and the stable insulating characteristic of an electrode film and the magnetic shielding films is assured in order to improve a surface recording density.

CONSTITUTION: The lower magnetic shielding film 12 is disposed on a substrate and a magneto-resistance sensor film 1 is disposed via an insulating film in the magnetosensitive part region on this lower magnetic shielding film 12. The electrode film 19 for energization is connected to the side face of the magneto-resistance sensor film 1. The thickness of the insulating film between the magneto-resistance sensor film 1 in the magnetosensitive part region and the lower magnetic shielding film 12 is set smaller than the thickness of the insulating film between the electrode film 19 and the lower magnetic shielding film 12.



## LEGAL STATUS

[Date of request for examination] 28.02.2001

[Date of sending the examiner's decision of 20.04.2004

rejection]

[Kind of final disposal of application other than  
the examiner's decision of rejection or  
application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's 2004-10495  
decision of rejection]

[Date of requesting appeal against examiner's 20.05.2004  
decision of rejection]

[Date of extinction of right]

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CLAIMS

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[Claim(s)]

[Claim 1] A substrate, the lower magnetic-shielding film prepared on this substrate, and the magnetic-reluctance sensor film prepared in the magnetic force sensor field on this lower magnetic-shielding film through the insulator layer, In the magneto-resistive effect mold head which has the electrode layer for energization connected to the side face of this magnetic-reluctance sensor film The magneto-resistive effect mold head to which thickness of the insulator layer between the above-mentioned magnetic-reluctance sensor film and the lower magnetic-shielding film is characterized by being thinner than the thickness of the insulator layer between the above-mentioned electrode layer and the lower magnetic-shielding film.

[Claim 2] It is the magneto-resistive effect mold head characterized by the above-mentioned lower magnetic-shielding film having heights to the above-mentioned magnetic force sensor field in a magneto-resistive effect mold head according to claim 1.

[Claim 3] It is the magneto-resistive effect mold head characterized by all or the principal part of the thickness directions consisting of the quality of the material in which the insulator layer between the above-mentioned electrode layer and the lower magnetic-shielding film differs from the above-mentioned magnetic-reluctance sensor film and the insulator layer between lower magnetic-shielding film in a magneto-resistive effect mold head according to claim 1.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the magneto-resistive effect mold head used for the magnetic-recording field, for example, a magnetic disk drive etc.

[0002]

[Description of the Prior Art] In recent years, the magnetic recording medium which used the magneto-resistive effect mold head (henceforth an MR head) as a head for high density record playback is used increasingly. In order for this MR head to inhibit a Barkhausen noise and to secure an active region with sufficient linearity, it is known that the bias field of a lengthwise direction and a longitudinal direction must be impressed to the magnetic-reluctance sensor film.

[0003] Moreover, as an MR head of the narrow track width of face corresponding to high density record, the magnetic-reluctance sensor film is limited and arranged only to a magnetic force sensor at JP,3-125311,A, and the MR head of the narrow track width of face which was excellent in the sensitivity profile of structure which connected the electrode on the side face of the magnetic-reluctance sensor film is indicated. This MR head forms the electrode layer linked to this, and is manufactured while carrying out taper etching of the magnetic-reluctance sensor film by the ion milling method which controlled the angle of incidence of an ion beam, using a photoresist as mask material.

[0004]

[Problem(s) to be Solved by the Invention] Although it is required in the field of magnetic recording to raise surface recording density increasingly from now on, and to go, in order to raise surface recording density, it is required to also raise track recording density sharply in addition to track density, and to go. For that purpose, it is necessary to make small the gap length of an MR head, i.e., spacing of the lower shielding film of a magnetic force sensor field (active region of the magnetic-reluctance sensor film), and the up shielding film.

[0005] The conventional technique of a publication had the problem that spacing of the lower shielding film of a magnetic force sensor field and the up shielding film was not a size corresponding to high density record in above-mentioned JP,3-125311,A. Since over etching of the insulator layer of a substrate will be carried out when etching the magnetic-reluctance sensor film by ion milling if the insulator layer of this MR head is made thin, insulating reservation with the electrode layer and lower shielding film which were formed on this is difficult.

[0006] The purpose of this invention has small spacing of the lower shielding film of a magnetic force sensor field, and the up shielding film, and it is to offer the magneto-resistive effect mold head which secured the stable insulation of an electrode layer and the magnetic-shielding film.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the magneto-resistive effect mold head of this invention A substrate, the lower magnetic-shielding film prepared on the substrate, and the magnetic-reluctance sensor film prepared in the magnetic force sensor field on the lower magnetic-shielding film through the insulator layer, It has the electrode layer for energization

connected to the side face of this magnetic-reluctance sensor film, and is made to make thickness of the insulator layer between the magnetic-reluctance sensor film and the lower magnetic-shielding film thinner than the thickness of the insulator layer between an electrode layer and the lower magnetic-shielding film.

[0008] This magneto-resistive effect mold head can be made into the structure which prepared heights in the lower magnetic-shielding film of a magnetic force sensor field. Such a magneto-resistive effect mold head can be manufactured easily as follows, for example. Thickness other than the magnetic force sensor field in which the lower magnetic-shielding film is formed on a substrate, and the magnetic-reluctance sensor film of this lower magnetic-shielding film is formed is made thin, the 1st insulator layer and the 2nd insulator layer are formed on it, and the 2nd insulator layer of a magnetic force sensor field is deleted and manufactured.

[0009] Moreover, the above-mentioned magneto-resistive effect mold head can also make all or the principal part of the thickness directions of an insulator layer between an electrode layer and the lower magnetic-shielding film the different quality of the material from the magnetic-reluctance sensor film and the insulator layer between lower magnetic-shielding film. Such a magneto-resistive effect mold head can be manufactured easily as follows, for example. First, the lower magnetic-shielding film, the 1st insulator layer, and the magnetic-reluctance sensor film are formed on a substrate, and magnetic-reluctance sensor film other than a magnetic force sensor field and the 1st insulator layer are removed. At this time, upside [ a part of ] was removed and a part of 1st insulator layer may remain. Subsequently, the 1st insulator layer forms the 2nd insulator layer in the field removed substantially. Thus, if an insulator layer is formed with the different quality of the material in 2 steps, the above-mentioned structure can be manufactured easily.

[0010]

[Function] If thickness of the insulator layer between the magnetic-reluctance sensor film of a magnetic force sensor field and the lower magnetic-shielding film is made thin, spacing of the lower shielding film and the up shielding film can be made thin, and it can respond to high density record. On the other hand, the thickness of the insulator layer between an electrode layer and the lower magnetic-shielding film can secure the stable insulation of an electrode layer and the lower magnetic-shielding film by making it thicker than the thickness of the insulator layer of the above-mentioned magnetic force sensor field.

[0011]

[Example] Hereafter, the example of this invention is explained using a drawing.

<Example 1> Drawing 1 is partial structural drawing for the 1st component section structural drawing, drawing 2 , and drawing 3 of a medium confrontation side (surfacing side) of an example of an MR head to show the production process. [ of this invention ] On a substrate 10, the substrate film 11 and the lower shielding film 12 with a thickness of 2 micrometers are formed, and about 0.5 micrometers of parts other than some lower shielding film 12, i.e., the field of the magnetic-reluctance sensor film 1 formed in behind, are etched by ion milling so that thickness may become thin. The width of face of the heights of the lower shielding film 12 formed here is 2 micrometers, and is equivalent to the width of recording track of a record medium. Usually, it is desirable to be referred to as 1.5 to 3 micrometers. Although the amorphous alloy film of the NiFe film which is soft magnetism film was used for the lower shielding film 12, amorphous alloy film, such as CoNbZr, is sufficient.

[0012] Then, as shown in drawing 2 , the 1st insulator layer 13 with a thickness of 0.1 micrometers and the 2nd insulator layer 17 with a thickness of about 1 micrometer are formed, and it is processed until the 1st insulator layer 13 is exposed as shown in drawing 3 , and an outline flat side is acquired by polishing processing. The thickness of the 1st insulator layer 13 has 0.05 to desirable 0.1 micrometers, and the thickness of the 2nd insulator layer 17 should just be 0.5 micrometers or more of the thickness which carried out [ above-mentioned ] etching. Here, SiO<sub>2</sub> grade may be used for the 2nd insulator layer 17 although aluminum 2O<sub>3</sub> was used for the carbon insulator layer (diamond-like carbon film) and the 2nd insulator layer 17 which are hard to be processed by polishing processing by hard into the 1st insulator layer 13.

[0013] Drawing 4 and drawing 5 are partial structural drawings having shown another way when forming this flat side, and the 1st insulator layer 13 of them is the same as that of the structure which forms the insulator layer 27 which is equivalent to the 1st insulator layer again, and is functionally shown in drawing 3 from the condition or the condition of no longer being processed which was processed in part and became thin in this case.

[0014] Then, as shown in partial structural drawing shown in drawing 6, although the magnetic-reluctance sensor film 1 shown in drawing 1 is formed, this magnetic-reluctance sensor film 1 consists of film of three or more layers. In the example of drawing 6, continuation formation of the software bias film 14, a demarcation membrane 15, and the MR film 16 is carried out. Here, using NiFeCr, NiFeNb, etc. which are the high resistance soft magnetism alloy generally known on the software bias film 14, using NiFe, a cascade screen is formed in Ta and the MR film 16 one by one, and it goes for a demarcation membrane 15 to them.

[0015] Next, alignment of the stencil 31 used as mask material as shown in drawing 6 is carried out at the place where the thickness of the lower shielding film 12 is thick, it forms by the photoresist, and three layers, the software bias film 14, a demarcation membrane 15, and the MR film 16, are etched by ion milling. In order to acquire a required side-face taper angle at this time, it etches setting the angle of incidence of an ion beam as the big value of 45 degrees or more, and rotating a substrate. Here, although the 2nd insulator layer 17 will also be etched a little as over-etching of the part within a substrate side is carried out and it is shown in drawing 6 in order to etch the inside of a substrate side certainly, since thickness is made sufficiently thick, the thickness which needs the 2nd insulator layer 17 on the lower shielding film 12 will be secured.

[0016] Then, from this condition, with the stencil 31 left, as shown in drawing 7, continuous laminating of the vertical bias film 18 and electrode layer 19 for impressing vertical bias to the MR film 16 is carried out. Although Ta/Au/Ta of low resistance was used for the vertical bias film 18 at the hard film of CoCrPt, and an electrode layer, the cascade screen of NiMn/NiFe etc. is sufficient as the vertical bias film 18, and the cascade screen of Ta/W/Ta etc. is sufficient as an electrode layer. The forming method is formed by the usual spatter with a big surroundings lump of a metal membrane covering particle. Even if it manufactures by which approach, in this example, the lower layer side of the magnetic-reluctance sensor film and the vertical bias film is substantially flat.

[0017] Then, removal of a stencil 31 acquires the configuration shown in drawing 8. As shown in drawing 9 after this, the up gap film 20 and the up shielding film 21 of the same quality of the material as the lower shielding film are formed, the light gap film 22 shown in drawing 1, a coil (not shown), an interlayer insulation film (not shown), the light core 25, a protective coat 26, a terminal (not shown), etc. are formed, and an MR head is completed. Drawing 10 is the partial perspective view of this MR head, and shows the location of a coil 23 and interlayer insulation film 24 grade.

[0018] <Example 2> Drawing 11 is partial structural drawing for drawing 12 to component section structural drawing of the medium confrontation side (surfacing side) of the MR head of the 2nd example of this invention and drawing 16 to show the production process. On a substrate 10, the substrate film 11, the lower shielding film 12, and the 1st insulator layer 13 are formed, and the magnetic-reluctance sensor film 1 is formed continuously. Although [ the quality of the material of the lower shielding film 12 and the 1st insulator layer 13, and thickness ] it is the same as an example 1, it is not a carbon insulator layer and high grade metallic compounds with insulation, such as silicon nitride, an alumina, and a titania, etc. may be used for the 1st insulator layer 13.

[0019] The magnetic-reluctance sensor film 1 consists of three layers, the software bias film 14, a demarcation membrane 15, and the MR film 16, as shown in drawing 12, and it carries out continuation formation of these. The ingredient of example 1 publication is used for these software bias film 14, a demarcation membrane 15, and the MR film 16.

[0020] Next, it etches setting the angle of incidence of an ion beam as the big value of 45 degrees or more, and rotating a substrate, in order to acquire a required side-face taper angle at this time, although the stencil 31 used as mask material as shown in drawing 12 is formed by the photoresist and three layers, the software bias film 14, a demarcation membrane 15, and the MR film 16, are etched by ion

milling, and is \*\*. Here, in order to etch the inside of a substrate side certainly, over-etching of the part within a substrate side is carried out, and as shown in drawing 12, this film will also be etched when the 1st insulator layer 13 is thin.

[0021] Then, from this condition, with a stencil left, as shown in drawing 13, the 2nd insulator layer 17 with a thickness of 0.2 micrometers - 0.3 micrometers is formed, but using the collimation spatter method which made [ many ] the approach, for example, the ion beam spatter method, to force it the directivity of the insulator layer covering particle 32, or the rectilinear-propagation particle, the membrane formation approach is formed so that the 1st some or all of a side face of an insulator layer 13 may be covered. Moreover, since this film is made into required thickness when securing an insulation, it can use a common metallic oxide, a metal nitride, for example, silicon nitride, an alumina, a titania, etc. By this, since it forms to the 2nd insulator layer 17 using the same mask material, it will be hard to produce a location gap, and the insulation with the electrode layer and lower shielding film which are formed after this can also be secured certainly.

[0022] After this, by this example, in order to ensure contact on MR film side face at this time although the vertical bias film 18 for impressing vertical bias to the MR film 16 is formed as shown in drawing 14, it irradiates from across using Ar ion, and it is desirable to clean a side face in advance, and it carries out continuous laminating of the vertical bias film 18 and the electrode layer 19. The forming method is formed in the vertical bias film 18 and an electrode layer 19 using the same ingredient as an example 1 by the usual spatter with a big surroundings lump of the metal membrane covering particle 33.

[0023] Then, as shown in drawing 15, a stencil 31 is removed, the up gap film 20 and the up shielding film 21 are formed, the light gap film 22 shown in drawing 11, a coil (not shown), an interlayer insulation film (not shown), the light core 25, a protective coat 26, a terminal (not shown), etc. are formed, and an MR head is completed. Drawing 17 is the partial perspective view of this MR head, and shows the location of a coil 23 and interlayer insulation film 24 grade. Drawing 16 is partial structural drawing when the 1st insulator layer 13 is not etched completely, and, as for the insulator layer under an electrode layer 19, it is clear that the greater part of that thickness consists of the 2nd insulator layer 17, and the same insulating effectiveness is acquired also in this case.

[0024]

[Effect of the Invention] As explained above, the MR head of this invention was able to prevent the insulation deterioration of an electrode layer and the lower shielding film while being able to keep narrow spacing of the lower shielding film of a magnetic force sensor field, and the up shielding film.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] Component section structural drawing of the medium confrontation side of the MR head of the 1st example of this invention.

[Drawing 2] Partial structural drawing to show the production process of the MR head of the 1st example of this invention.

[Drawing 3] Partial structural drawing to show the production process of the MR head of the 1st example of this invention.

[Drawing 4] Partial structural drawing to show other production processes of the MR head of the 1st example of this invention.

[Drawing 5] Partial structural drawing to show other production processes of the MR head of the 1st example of this invention.

[Drawing 6] Partial structural drawing to show the production process of the MR head of the 1st example of this invention.

[Drawing 7] Partial structural drawing to show the production process of the MR head of the 1st example of this invention.

[Drawing 8] Partial structural drawing to show the production process of the MR head of the 1st example of this invention.

[Drawing 9] Partial structural drawing to show the production process of the MR head of the 1st example of this invention.

[Drawing 10] The partial perspective view of the component section of the MR head of the 1st example of this invention.

[Drawing 11] Component section structural drawing of the medium confrontation side of the MR head of the 2nd example of this invention.

[Drawing 12] Partial structural drawing to show the production process of the MR head of the 2nd example of this invention.

[Drawing 13] Partial structural drawing to show the production process of the MR head of the 2nd example of this invention.

[Drawing 14] Partial structural drawing to show the production process of the MR head of the 2nd example of this invention.

[Drawing 15] Partial structural drawing to show the production process of the MR head of the 2nd example of this invention.

[Drawing 16] Partial structural drawing to show other production processes of the MR head of the 2nd example of this invention.

[Drawing 17] The partial perspective view of the component section of the MR head of the 2nd example of this invention.

[Description of Notations]

1 -- Magnetic-reluctance sensor film

10 -- Substrate

- 11 -- Substrate film
- 12 -- Lower shielding film
- 13 -- The 1st insulator layer
- 14 -- Software bias film
- 15 -- Demarcation membrane
- 16 -- MR film
- 17 -- The 2nd insulator layer
- 18 -- Vertical bias film
- 19 -- Electrode layer
- 20 -- Up gap film
- 21 -- Up shielding film
- 22 -- Light gap film
- 23 -- Coil
- 24 -- Interlayer insulation film
- 25 -- Light core
- 26 -- Protective coat
- 27 -- Insulator layer
- 31 -- Stencil
- 32 -- Insulator layer covering particle
- 33 -- Metal membrane covering particle

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[Translation done.]

## \* NOTICES \*

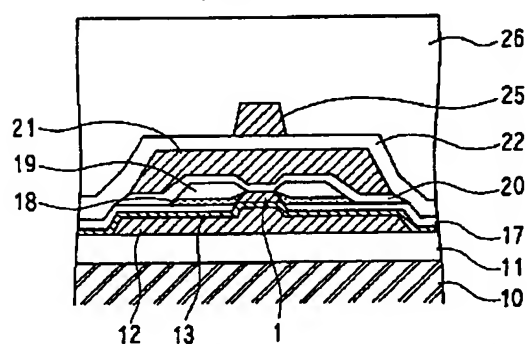
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3. In the drawings, any words are not translated.

## DRAWINGS

[Drawing 1]

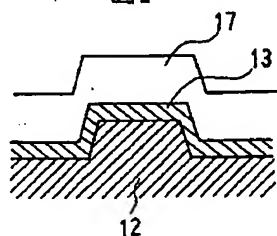
図 1



- |              |               |
|--------------|---------------|
| 12...下部シールド膜 | 20...上部ギャップ膜  |
| 13...第1の絶縁膜  | 21...上部シールド膜  |
| 17...第2の絶縁膜  | 22...ライトギャップ膜 |
| 18...縦バイアス膜  | 25...ライトコア    |
| 19...電極膜     | 26...保護膜      |

[Drawing 2]

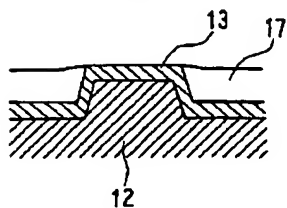
図 2



- |              |             |
|--------------|-------------|
| 12...下部シールド膜 | 17...第2の絶縁膜 |
| 13...第1の絶縁膜  |             |

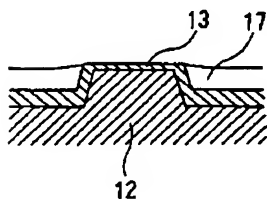
[Drawing 3]

図 3



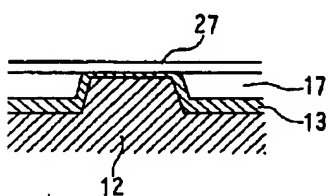
[Drawing 4]

図 4



[Drawing 5]

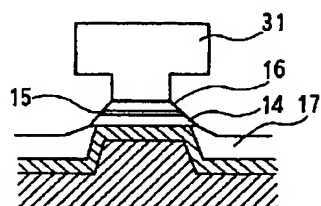
図 5



27...絶縁膜

[Drawing 6]

図 6



14...ソフトバイアス膜

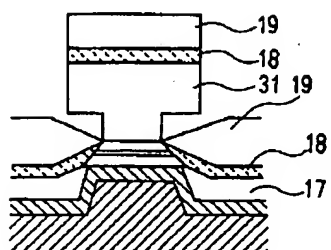
16...MR膜

15...分離膜

31...ステンシル

[Drawing 7]

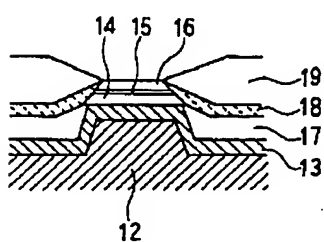
図 7



18…縦バイパス膜  
19…電極膜

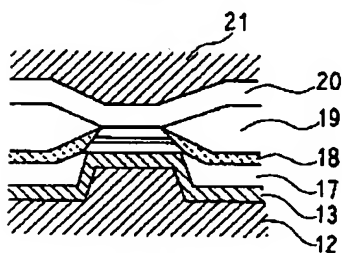
[Drawing 8]

図 8



[Drawing 9]

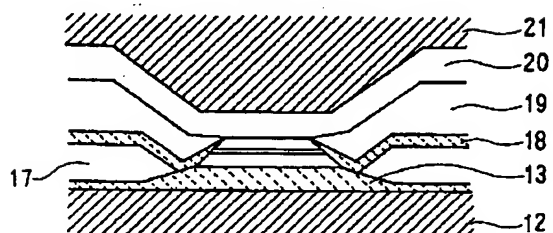
図 9



20…上部ギャップ膜  
21…上部シールド膜

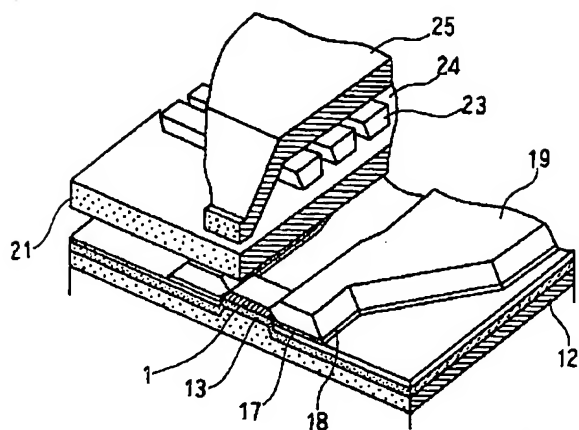
[Drawing 16]

図 16



[Drawing 10]

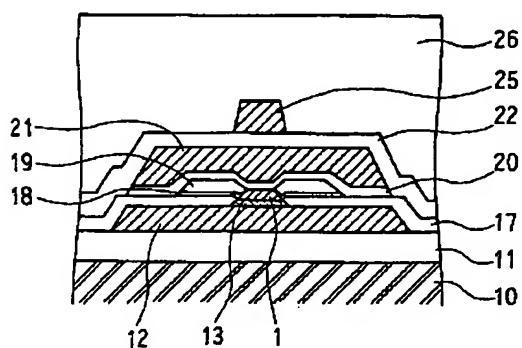
図 10



- |             |              |
|-------------|--------------|
| 13...第1の絶縁膜 | 21...上部シールド膜 |
| 17...第2の絶縁膜 | 23...コイル     |
| 18...縦バイアス膜 | 24...層間絶縁膜   |

[Drawing 11]

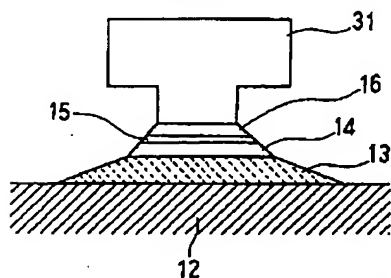
図 11



- |              |               |
|--------------|---------------|
| 12...下部シールド膜 | 20...上部ギャップ膜  |
| 13...第1の絶縁膜  | 21...上部シールド膜  |
| 17...第2の絶縁膜  | 22...ライトギャップ膜 |
| 18...縦バイアス膜  | 25...ライトコア    |
| 19...電極膜     | 26...保護膜      |

[Drawing 12]

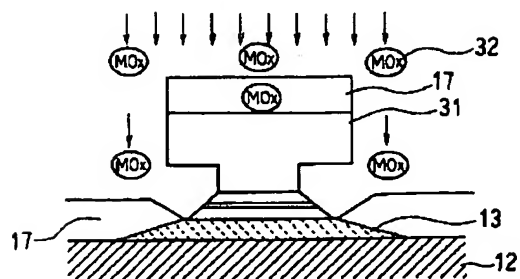
図 12



- |              |            |
|--------------|------------|
| 12...下部シールド膜 | 15...分離膜   |
| 13...第1の絶縁膜  | 16...MR膜   |
| 14...第2の絶縁膜  | 31...ステンシル |

[Drawing 13]

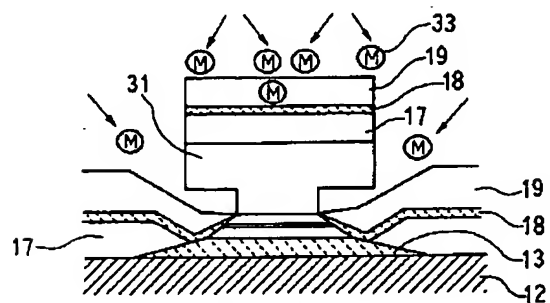
図 13



32...絶縁膜被着粒子

[Drawing 14]

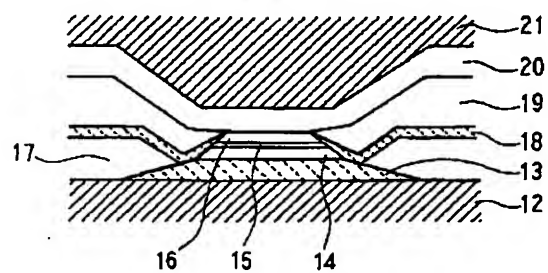
図 14



33...金属膜被着粒子

[Drawing 15]

図 15



18...縦バイアス膜

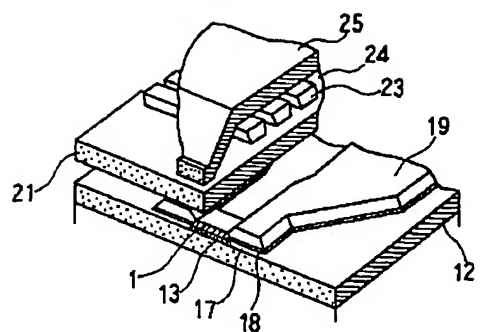
20...上部ギャップ膜

19...電極膜

21...上部シールド膜

[Drawing 17]

図 17



- |             |              |
|-------------|--------------|
| 13...第1の絶縁膜 | 21...上部シールド膜 |
| 17...第2の絶縁膜 | 23...コイル     |
| 18...縦バイアス膜 | 24...層間絶縁膜   |

[Translation done.]



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